Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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THE ORIGIN OF COAL: A SUGGESTION.

By G. W. BULMAN, M.A., B.Sc.

PROFESSOR SHALER'S estimate of the rate of formation of coal is $\frac{1}{10}$ inch per year. This is doubtless based on reliable experimental data as to the rate at which vegetable deposits are being formed at the present day. Those, however, who study carefully the phenomena of the coal seams of our Coal Measures can hardly avoid the conviction that this rate of formation is much too slow. Professor Prestwick, perhaps the most philosophical and far-seeing of modern geologists, says: "I am therefore led to conclude that the coal-growth was in all probability one of extreme rapidity."

Yet among geologists in general it is almost an article of faith—an axiom to be admitted without discussion—that it was rather a matter of *extreme slowness*.

Let us consider in detail some of the difficulties in supposing that the accumulation of vegetable matter which now forms coal could have taken place at the rate suggested by Professor Shaler's estimate; and this, be it noted, would be considered a liberal—if not excessive—rate by most geologists. The initial, and perhaps greatest, difficulty is to get the mass of vegetation which is to form the coal buried before it has time to decay. Consider a three-foot seam of coal on the $\frac{1}{10}$-inch-per-year theory. Thirty-six inches of coal at this rate would require three hundred and sixty years to accumulate. Are we justified in supposing that such an increasing mass of vegetation could remain exposed to the air for over three centuries without decay? It seems imperative that if vegetation is to be converted into coal it should be buried *quickly*. What, then, is the longest time we can expose a mass of leaves, spores, and so on, to the air without decay setting in?—and in a warm and humid climate, such as that of Carboniferous times is generally supposed to have been, decay may well have been even more rapid than it is to-day.

And then there is the difficulty of understanding how one's season's growth could spring up on the accumulation of those of the past. Sir A. Geikie, indeed ("Class Book of Geology," page 271) speaks of "successive generations of plants springing up on the remains of their predecessors." But how could plants grow on a layer of fresh or partly mineralised vegetation when enough of this had accumulated to form, say, an inch of coal? Had the fallen leaves and stems decayed and mingled with the soil we could understand a fresh crop thus springing up. But the case does not admit the belief that this was so. For *decayed* vegetation mingled with *soil* could not form coal, and we cannot suppose that plants normally fitted to grow in clay—as those of Carboniferous times seem to have been—could establish themselves on a heap of fresh leaves or a layer of semi-coal. And if they did thus grow on, and at the expense of, the accumulated vegetation, would they not alter it? Would they not decompose it, and hinder its conversion into coal? We seem, in fact, forced to the conclusion that any layer of pure coal—which may vary from an inch to three feet—must be the product of a single generation of plants; and since the mass of vegetation must be quickly buried, the further suggestion forces itself upon us that every such layer must be *a one season's growth*. For we can scarcely leave our mass of vegetation unburied for more than a year with

XUM

any hope of its ultimate conversion into coal.

It is generally believed that the Carboniferous vegetation was of a somewhat quick-growing type —"vegetation which from its nature and the character of the climate was in all probability one of very rapid growth, and of equally rapid fall and decay."

But, granting it all the rapidity we reasonably can, it is astounding to an orthodox geologist—such as the writer claims to be—to be thus forced to the conclusion that anything from an inch to three feet of coal may be formed from one season's growth! Yet we sometimes get even a further indication that a single layer of coal may be the product of one year's growth. Occasionally a tree is found with its roots in the underclay, and its stem passing up through the coal into the sandstone above. If it is a two-foot seam of coal, then we must suppose, on the $\frac{1}{10}$-inch-a-year theory, that the tree stood, not only for the two hundred and forty years required for the formation of the coal, but also for the, say, eight hundred years required to bury its eight feet of stem in mud. It is surely more in accordance with probability to believe that such a tree was one of the original crop that sprang up first on the clay, and which, by their abundant spores and leaves, as well as by many of their own prostrate trunks, built up the two-foot seam of coal. Nor do we seem at liberty to hypothesise more than a year for the burying of the projecting eight feet of trunk.

Thus the hypothesis of an annual growth for each seam of pure coal appears to remove two difficulties. We get the mass of vegetation buried quickly enough to prevent decay, and we have no need to suppose that a fresh generation sprang up on a bed of undecayed leaves; and it further serves to explain a peculiarity of coal seams which has not hitherto been satisfactorily fitted into any theory of coal-formation. We allude to the *partings* which occur in almost all coal seams over three feet in thickness. As an example, let us take the section of the Beeston-bed coal as given in *The Geological Survey Memoir* of the Yorkshire Coalfield:

	Ft.	In.
Coal	2	0
Underclay	0	3
Coal	1	3
Underclay	0	5
Coal	0	5
Underclay	1	6
Coal	0	6
Underclay	0	2
Coal	0	2
Underclay	0	7
Coal	0	2
Underclay	0	2
Coal	1	8½
	9	3½

Now, on the usual theory that each layer of coal was formed on land, and the underclay in a sea or lake, we have to assume seven separate sinkings of the land, and as many pauses for the growth of the coal; and the sinkings must have been such that from two inches to one and a half foot of clay was sufficient to make new land again. For such earth-movements we have no warrant. But let us suppose that the lower one foot eight and a half inches of coal was formed by a season's growth during the summer half of the year. The leaves and spores are shed, and most of the trunks are fallen. Then the rivers from the uplands bordering the great flat, swampy areas bring down mud, and spread two inches of clay over the vegetable matter. It is now carefully sealed up, and can turn to coal at its leisure. Then as the summer returns the waters dry up, and a fresh growth of coal—two inches this time—takes place. This in turn is sealed up with seven inches of mud brought down by the floods of the succeeding winter. So the process goes on without the assistance of any land movements until the seven layers of coal are formed and sealed up with mud. To account for the mud not being brought into the swamp during the summer to mingle with the vegetation we may suppose that the rivers only carried mud in the winter. Possibly—like the Nile—they were rivers of only one flood in the year, only theirs was in winter instead of summer. Or we may adopt the suggestion of Sir Charles Lyell, that the swamp was surrounded by a dense fringe of vegetation which acted as a filter for the muddy waters of the rivers. When this vegetation died down in the winter the mud would be admitted, and spread over the summer's growth. The varying thickness of coal layers and partings may be the reflections of a climate varying slightly from year to year—one year a more luxuriant growth of vegetation in summer, another severer winter floods.

If we add on to the section two and a half inches of clay as the contribution of the winter floods following the summer's growth of two feet of coal we get nine and a half feet of rock; and this, according to one theory, was accumulated in seven years—a rate of one hundred and thirty-six feet in one hundred years instead of the one foot allowed by Professor Sollas! Surely a conclusion calculated to make the hair of an orthodox geologist stand on end! If we take it as the average rate—and the strata we are considering are among those usually considered to be the most slowly formed of all—we reduce Professor Sollas's meagure twenty-six million years as the geological age of the Earth to some one hundred and ninety-two thousand!

The ideas here put forward have been suggested by the actual facts of the coal seams themselves. However they may strike his readers, they have proved sufficiently startling to the writer.

WEATHER FOLKLORE.

By LIONEL E. ADAMS, B.A.

As the life of people becomes more civilised and artificially protected against wind and wet, cold and heat, the less is there personal need of weather forecast; and we often find city dwellers indifferent to, if not absolutely unconscious of climatic conditions. But to the countryman, whose personal comfort and business success depend upon the weather, the observation of weather phenomena is of daily importance. Putting aside the systematised lore of the priests of ancient peoples, it is to the cultivators of the land and to the toilers of the sea that we owe the accumulation of weather folklore that should be collected in book form before it is forgotten.

Perhaps the most familiar weather forecasts relate to sunset and sunrise. Virgil, in his first book of the "Georgics," has collected some interesting folklore relating to the subject. He says: "The Sun, too, will give some tokens, both when he rises and when he sinks beneath the ocean-floor. Surest the tokens which attend him, whether he brings them with returning morn or shows than to the peeping stars! When his birth-hour sees him sicklied over with blemishes, cloud-cast, and half his orb withdrawn, suspect rain, for the south wind, foe of tree and corn and herd, is driving from the deep. If either at dawn the rays break scattered through dense clouds, or Aurora rises pale from Tithonus' couch of saffron—alas! the vine leaf will but feebly champion in ripened clusters, so thick on the roof will dance the rattling shafts of hail. And this it will serve thee yet more to remember, when, with the traversed sky behind him, he is in act to depart; for often we may see shifting hues flit across his countenance. If these are dark, rain is heralded; if red, the storm-wind; but let specks begin to mingle with his ruddy flames, and shortly thou wilt see all nature turmoiled with wind and cloud alike. . . . But if his orb is bright alike when he brings back the day, and when he veils the day he brought, then the storm-cloud's menace is vain, and thou wilt see the woods swaying before the bright north wind." *

We find the same forecasts, more concisely put, in Matthew xvi, 2 and 3: "When it is evening, ye say, It will be fair weather: for the sky is red. And in the morning, It will be foul weather to-day: for the sky is red and lowering." To the same effect are our old country rhymes:

> "An evening red and a morning grey
> Are a sure sign of a fine day.
> An evening grey, and a morning red,
> Sends the shepherd wet to bed."

> "A rainbow in the morning
> Is the shepherd's warning;
> A rainbow at night
> Is the shepherd's delight."

Finally, we find the following up-to-date pronouncement in "Whitaker's Almanack," based on the observations of Admiral Fitzroy: "A rosy sky at sunset, whether clouded or clear, a grey sky in the morning, a low dawn (that is, when the first signs of the dawn appear on the horizon), all indicate fine weather. A red sky in the morning indicates bad weather, or much wind; and a high dawn (or when the first signs of the dawn are seen above a bank of clouds) presages wind."

It will be noticed that in all the foregoing forecasts there is exceedingly little in the way of discrimination among the various sorts of sunsets; that is to say, the different phenomena accompanying a red sunset or sunrise. We all know, for instance, that in an English summer, when the Sun sets as a red ball in a clear sky, the following day will be fine; but when surrounded by lurid, crimson-tinted clouds rain is most likely to follow. Again, when the Sun appears as a crimson disc through the mist of a winter morning a fine day is assured; but a gorgeous red sunrise in a clear sky is a very sure sign of a bad day to follow. It is not a little curious that in Palestine a red sunset should have been considered in any way ominous, as in that region the sunsets are nearly always red, due to the haze of desert dust, and rain rare; though it must be remembered that in ancient times much land that is now desert was under cultivation, and the climate not so arid as at the present day.

A "mackerel sky," which is caused by two cross-currents of air rolling the clouds into "pills," is supposed to herald rain, and, after a spell of fine weather, does so correctly, one of the two currents being the changing wind that is about to upset the present condition. But exactly for the same reason after a spell of wet weather such a sky is a hopeful sign of a change for the better. I have heard the following rhyme at sea:

> "Mackerel backs and mares' tails
> Make lofty ships carry low sails."

"Mares' tails," of course, indicate wind.

The poet Virgil goes on to describe the actions of various animals, most of which are recognised to-day by country people as indicative of an impending change in weather conditions. Before a gale, he says, "the wave can scarce refrain from assailing the crooked keel when the fleet cormorant comes flying back from mid-ocean and its shriek

* Jackson's translation.

XUM

nears the shore; when the sea-coot (gull) is sporting on dry land, and the heron quits her familiar marsh to soar above the clouds of heaven."

Regarding impending rain he writes: "Never man was harmed by rain but he was forewarned. . . . Often light chaff and fallen leaves will flit about thee, and feathers dance on the water-top. . . . The heifer looks up to heaven, sniffing the breeze with wide-opened nostrils; or the twittering swallow flits round her mere; the frog croaks his immemorial plaint in the mud. Often the ant threads her narrow path and brings out her eggs from their inmost cells; an army of rooks will quit its pasturage in long array with the beating of a cloud of wings. Then the villainous raven stalks in solitary state along the dry strand, and full-throatedly invokes the rain. Not even the girls, as they card the midnight wool, are unaware of the rain whenever they see the oil flicker in the burning lamp and a mushroom growth gather on the wick." Concerning the passing of the rain and the approach of fine weather he continues: "The uncleanly swine forgets to toss the dishevelled straw with his muzzle." I have heard country people say that pigs toss about the straw when rain is at hand, but I have no notion if this be the case. Finally, Virgil describes the joyful cawing of the rooks foretelling the clearing of the clouds.

Most of these saws are familiar to country dwellers in England, and were common to various peoples two thousand years ago, and much might be written about the explanation of some of them. A few more that are not so generally known may be of interest.

Perhaps field labourers and fishermen know better than the rest of mankind how, before thunder or rain, flies become intensely troublesome and midges bite viciously. This activity among insects is doubtless immediately perceived by the trout, which are well known to bite freely during a thunder-shower.

Not long ago our gardener remarked that he had heard the yaffles cry and prophesied rain. The next day it rained steadily. Now the Green Woodpecker is commonly known to country people as the "rain-bird," but whether it does utter its laugh more before rain than at other times I cannot say. I have often noted it pretty continuously when no rain followed. Near Aylesbury, on April 12th, 1911, I heard the laugh insistently on the change of wind from north-east to west; the rain, however, did not come for several days.

I have several times noticed that rabbits will feed in the open field during the day when a rainy night follows. An observant keeper always explained that the rabbits knew that the night would be wet, and they therefore took their meal before the rain came.

In the South of England farmers and others have predicted rain, always accurately, by the smoke from chimneys lying low; and at sea during stormy weather I have often noticed the smoke from the funnel drifting over the surface of the sea.

On a certain sunny afternoon in July, 1909, a farmer called my attention to the way in which the leaves of some oaks were turned up, showing their undersides and foretelling rain. A few minutes later I came across the keeper, who remarked the same fact. Asked if he could explain it, he said the wind blew them up, a current of air being drawn up around the tree, the reason of which he did not understand; which was all very obvious, but hardly informing. Later in the afternoon I noticed the white undersides of poplars were conspicuous, and in the evening rain came. The distinctness of detail on the hills around had indicated rain during the day.

One fine afternoon last August I cycled a few miles from home without suspecting a change. However, a thunderstorm came on, and I sought shelter in an outhouse, where I was joined by a roadmender, who was putting on a heavy overcoat. I asked how he came to have a coat on such a warm day, and he told me that he had anticipated the storm from the fact of the leaves falling from the trees during the morning, which had been calm and still, and that during his dinner-hour he had gone home to fetch his coat.

One of the quaintest, and perhaps most reliable, auguries that I have come across was that of an ancient mariner with whom I used to forgather on Dover Pier. He told me that in the cellar of his house was an iron water-pipe which he consulted daily by feel: "If the pipe sweated it would rain for sure." He knew nothing about condensation, but he had discovered the sequence of events.

Most people must have come upon little-known weather saws: these are always worth noting and testing and trying to account for, but this takes time. It is remarkable that Gilbert White has nothing to say on this subject.

A LOCUST STORM.

We are indebted to Mr. H. Stockwell for the photographs of a locust storm, taken by his sister in British East Africa, which are reproduced in Figures 115 to 118. The insects have been kindly identified by Mr. C. J. Gahan as *Schistocerca tartarica* Linn. (= *peregrinum* Oliv.).

A LOCUST STORM.

FIGURE 115. The cloud of locusts as seen from a hill.

FIGURE 116. The cloud coming nearer.

XUM

A LOCUST STORM.

FIGURE 117. The locust cloud taken close to the ground.

FIGURE 118. A view similar to that reproduced in Figure 117.

THE FACE OF THE SKY FOR AUGUST.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 34.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Aug. 3	8 53·0	N. 17·5	11 52·8	S. 4·3	9 21·6	N. 17·3	6 19·6	N. 17·5	12 25·5	S. 2·5	2 11·3	N. 11·8	21 22·8	S. 16·1
„ 8	9 12·2	16·2	16 15·3	S. 25·5	9 58·9	14·0	6 27·7	17·7	12 36·7	3·8	2 12·5	11·9	21 22·0	16·2
„ 13	9 31·1	14·7	21 28·6	S. 12·9	10 32·5	10·4	6 38·6	18·0	12 48·2	5·0	2 13·4	12·0	21 21·2	16·3
„ 18	9 49·8	13·1	1 48·7	N. 16·8	11 2·8	6·8	6 51·8	18·1	12 59·8	6·3	2 14·0	12·0	21 20·4	16·3
„ 23	10 8·3	11·5	6 12·3	N. 25·7	11 30·3	N. 3·2	7 7·0	18·2	13 11·6	7·6	2 14·3	12·0	21 19·6	16·4
„ 28	10 26·7	N. 9·7	10 12·9	N. 8·0	11 55·3	S. 0·3	7 23·7	N. 18·2	13 23·6	S. 8·9	2 14·3	N. 12·0	21 18·9	S. 16·4

TABLE 35.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Jupiter.	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Midnight. Moon.	Moon. P
	°	°	°		°	°	°	°	h. m.	h. m.		°
Aug. 3 ...	+11·8	+6·0	354·8	Aug. 7 ...	−20·6	+3·2	195·8	37·3	6 38 *m*	1 2 *m*	Aug. 3	+22·9
„ 8 ...	13·7	6·3	288·7	„ 14 ...	20·5	3·2	221·3	9·4	5 56 *m*	1 48 *m*	„ 8	+ 8·3
„ 13 ...	15·5	6·6	222·6	„ 21 ...	20·5	3·2	246·9	341·6	5 14 *m*	2 34 *m*	„ 13	−18·7
„ 18 ...	17·2	6·8	156·5	„ 28 ...	−20·5	+3·3	272·7	314·0	4 32 *m*	3 20 *m*	„ 18	−19·7
„ 23 ...	18·7	7·0	90·5								„ 23	+ 2·3
„ 28 ...	+20·2	+7·1	24·4								„ 28	+20·6

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}7$ respectively.

The data for the Moon in Table 35 are given for Greenwich midnight, *i.e.*, the midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving rapidly Southward. Its semi-diameter increases from 15′ 47″ to 15′ 53″. Sunrise changes from $4^h\ 24^m$ to $5^h\ 13^m$; sunset from $7^h\ 49^m$ to $6^h\ 48^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is an evening star, fairly well placed for observation. It reaches elongation, 27° East of Sun, on September 9th. Semi-diameter increases from 2½″ to 3″. Illumination full at beginning of month, two-thirds at end.

VENUS is a morning star, well placed for observation. At greatest brilliancy on 9th. At elongation, 46° West of Sun on September 12th. The semi-diameter diminishes from 21½″ to 13½″. Illumination of disc increases from $\frac{1}{6}$ to $\frac{1}{2}$.

THE MOON.—First quarter $6^d\ 9^h\ 6^m\ e$; Full 13^d noon; Last quarter $20^d\ 0^h\ 53^m\ e$. New $28^d\ 5^h\ 25^m\ e$. Perigee $12^d\ 9^h\ m$. Apogee $24^d\ 5^h\ e$. Semi-diameter 16′ 40″, 14′ 45″ respectively. Maximum librations 5^d 7° E., 5^d 7° N., 18^d 7° W., 18^d 7° S. September 1^d 7° N., September 2^d 6° E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 36.) Attention is called to the fact that Full Moon occurs when the Moon is unusually near the Earth.

MARS is advancing, with increased speed, in Virgo. It will be low in the West and badly placed for observation. Semi-diameter 2½″. Defect of illumination 0″·4. The North Pole of the planet is now turned towards the Earth and the Sun. The planet is in the part of its orbit that corresponds with the first half of August on Earth. The summer solstice of Mars' Northern Hemisphere was passed on May 6th. On August 4th the Earth and Mars will be in exactly corresponding parts of their year of seasons, each having travelled 132° in longitude from their position at the time of their vernal equinox.

JUPITER is a morning star in Aries, stationary on 25th. Equatorial diameter 44″, Polar 41″. Defect of illumination 0″·4.

Configuration of satellites at $1^h\ m$ for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Aug. 1	231	○	4		Aug. 17	1	○	234	
„ 2	4	○	31	2●	„ 18		○	2413	
„ 3	41	○	23		„ 19	241	○	3	
„ 4	42	○	13		„ 20	43	○	12	
„ 5	42	○	3	1●	„ 21	43	○	12	
„ 6	431	○	2		„ 22	4321	○		
„ 7	43	○	12		„ 23	42	○	1	3●
„ 8	4321	○			„ 24	41	○	23	
„ 9	42	○	31		„ 25	4	○	213	
„ 10	1	○	23		„ 26	241	○	3	
„ 11		⊙	143		„ 27	3	○	¼	2●
„ 12	2	○	34	1●	„ 28	3	○	24	1●
„ 13	3	⊙	24		„ 29	321	○	4	
„ 14	3	○	124		„ 30	23	○	14	
„ 15	321	○	4		„ 31	1	○	234	
„ 16	23	○	14						

Satellite 4 will be due north of the disc on 10th.

XUM

The following satellite phenomena are visible at Greenwich:—2^d 0^h 51^m 12^s *m* II. Ec. D., 3^h 28^m 1^s *m* II. Ec. R., 3^h 39^m *m* II. Oc. D.; 4^d 0^h 28^m *m* II. Tr. E., 1^h 51^m *m* I. Sh. I., 3^h 13^m *m* I. Tr. I., 4^h 0^m *m* I. Sh. E., 10^h 58^m 6^s *e* I. Ec. D.; 5^d 2^h 3^m *m* III. Sh. I., 2^h 32^m *m* I. Oc. R., 4^h 3^m *m* III. Sh. E., 10^h 28^m *e* I. Sh. E., 11^h 48^m *e* I. Tr. E.; 8^d 11^h 8^m *e* III. Oc. R.; 9^d 3^h 26^m 9^s *m* II. Ec. D.; 10^d 9^h 44^m *e* II. Sh. I.; 11^d 0^h 20^m *m* II. Sh. E., 0^h 31^m *m* II. Tr. I., 3^h 1^m *m* II. Tr. E., 3^h 44^m *m* I. Sh. I.; 12^d 0^h 52^m 16^s *m* I. Ec. D., 4^h 24^m *m* I. Oc. R., 9^h 57^m *e* II. Oc. R., 10^h 13^m *e* I. Sh. I., 11^h 33^m *e* I. Tr. I.; 13^d 0^h 22^m *m* I. Sh. E., 1^h 43^m *m* I. Tr. E., 10^h 52^m *e* I. Oc. R.; 15^d 9^h 55^m 56^s *e* III. Ec. R.; 16^d 1^h 39^m *m* III. Oc. D., 2^h 56^m *m* III. Oc. R.; 18^d 0^h 21^m *m* II. Sh. I., 2^h 57^m *m* II. Sh. E., 3^h 3^m *m* II. Tr. I.; 19^d 2^h 46^m 30^s *m* I. Ec. D., 9^h 54^m 24^s *e* II. Ec. R., 9^h 55^m 21^s *e* II. Oc. D.; 20^d 0^h 6^m *m* I. Sh. I., 0^h 25^m *m* II. Oc. R., 1^h 23^m *m* I. Tr. I., 2^h 16^m *m* I. Sh. E., 3^h 31^m *m* I. Tr. E., 9^h 15^m 1^s *e* I. Ec. D.; 21^d 0^h 43^m *m* I. Oc. R., 9^h 58^m *e* I. Tr. E.; 22^d 11^h 57^m 10^s *e* III. Ec. D.; 23^d 1^h 56^m 24^s *m* III. Ec. R.; 25^d 2^h 58^m *m* II. Sh. I.; 26^d 4^h 40^m 47^s *m* I. Ec. D., 9^h 53^m 6^s *e* II. Ec. D.; 27^d 2^h 0^m *m* I. Sh. I., 2^h 50^m *m* II. Oc. R., 3^h 13^m *m* I. Tr. I., 4^h 9^m *m* I. Sh. E., 11^h 9^m 19^s *e* I. Ec. D.; 28^d 2^h 33^m *m* I. Oc. R., 9^h 15^m *e* II. Tr. E., 9^h 40^m *e* I. Tr. I., 10^h 38^m *e* I. Sh. E., 11^h 47^m I. Tr. E.; 29^d 9^h 0^m *e* I. Oc. R.; 30^d 3^h 58^m 30^s *m* III. Ec. D. Attention is called to the rare phenomenon of the evening of the 19th, when II. reäppears from eclipse one minute before it disappears in occultation. Eclipses of the satellites take place low left of the disc, taking the direction of the belts as horizontal.

SATURN is invisible, having been in conjunction with Sun on July 12th.

URANUS is in opposition on 10th. It is in Capricornus. Semi-diameter $1''{\cdot}8$.

NEPTUNE is invisible, having been in conjunction with Sun on July 25th.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s{\cdot}83$ per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 37.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

TABLE 37.

Day.	Vega.			β Capricorni.		
	N. Dec. 38° 42′.			S. Dec.		
	h.	m.	s.	h.	m.	s.
July 28.....	10	9	12.47	11	51	8·80
Aug. 7.....	9	29	53·28	11	11	49·77
,, 17.....	8	50	34·05	10	32	30·71
,, 27.....	8	11	14·78	9	53	11·59

SUN after clock August 1st, $370^s{\cdot}02$; August 6, $345^s{\cdot}22$ August 11, $305^s{\cdot}18$; August 16, $250^s{\cdot}84$; August 21, $183^s{\cdot}78$; August 26, $105^s{\cdot}55$; August 31, $17^s{\cdot}65$. These are the equations of time for the moment of solar transit at Greenwich.

VARIABLE STARS.—Stars reaching their maxima in or near August, 1916, are included. The lists in recent months may also be consulted. (See Table 38.)

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.			Remarks.
	R.A.		Dec.	
	°		°	
May 30–Aug. ...	333	+	28	Swift, streaks.
June–Aug. ...	310	+	61	Swift, streaks.
June–Sept. ...	335	+	57	Swift.
June–Aug. ...	303	+	24	Swift.
July–Aug. ...	308	−	12	Slow, long.
July 25–Sept. 15	48	+	43	Swift, streaks.
July–Aug. ...	339	−	27	Slow.
July–Aug. ...	280	+	57	Slow, short.
July–Oct. ...	355	+	72	Swift, short.
Aug. 10–13 ...	45	+	57	Swift, streaks.
Aug.–Sept. ...	353	−	11	Rather slow.
Aug. 15	290	+	53	Swift, bright.
Aug. 15–25 ...	291	+	60	Slow, bright.
Aug. 25	5	+	11	Slow, short.
Aug.–Sept. ...	346		0	Slow.
Aug.–Oct. 2 ...	74	+	42	Swift, streaks.
Aug.–Sept. ...	63	+	22	Swift, streaks.

The Perseids may be seen from July 19, when the radiant is 19° + 50°. The R.A. increases 1° per day, the Dec. 1° in 3 days.

TABLE 36. Occultations of Stars by the Moon, visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1916.			h. m.	°	h. m.	°
Aug. 5 ...	87 Virginis	5·8	8 0 *e*	139	9 1 *e*	262
,, 9 ...	4G Sagittarii	6·2	9 7 *e*	3	9 19 *e*	345
,, 9 ...	WZC 1151	6·8	9 36 *e*	52	—	—
,, 10 ...	127 G Sagittarii...	6·4	11 48 *e*	46	0 46**m	278
,, 11 ...	172 B Sagittarii...	5·8	0 41 *m*	58	—	—
,, 15 ...	WZC 1530	6·6	—	—	1 38 *m*	308
,, 15 ...	λ Piscium	4·6	8 26 *e*	63	9 24 *e*	240
,, 17 ...	136 B Piscium	6·5	1 26 *m*	15	2 21 *m*	277
,, 25 ...	Saturn	0·4	9 42 *m*	82	10 52 *m*	325

The asterisk indicates the day following that given in the date column.

From New to Full Disappearances occur at the Dark Limb; from Full to New, Reäppearances.

TABLE 38. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
T Ceti	0 17 28	−20 32	5·4 to 6·9	162	1916—Aug. 25
X Camelopardi	4 34 29	+74 58	7·3 to 13·1	142	,, Aug. 26
R Aurigae	5 10 25	+53 30	6·5 to 13·3	456	,, Aug. 7
U Orionis	5 50 47	+20 10	5·8 to 12·1	374	,, Aug. 26
RS Virginis	14 23 1	+ 5 4	7·0 to 13·8	355	,, Aug. 19
V Ophiuchi	16 22 0	−12 14	6·9 to 10·8	302	,, Aug. 12
W Lyrae	18 11 59	+36 39	7·3 to 12·5	196	,, Aug. 18
R Sagittarii	19 11 42	−19 27	7·0 to 13·5	269	,, Aug. 6
R Cygni	19 34 33	+50 0	5·9 to 13·8	426	,, Aug. 16
R Vulpeculae	21 0 36	+23 29	7·1 to 13·6	137	,, Aug. 29

Minima of Algol $13^d\ 6^h\cdot1\ m$, $16^d\ 2^h\cdot9\ m$, $18^d\ 11^h\cdot7\ e$, $21^d\ 8^h\cdot5\ e$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $12^d\ 7^h\cdot5\ e$, $25^d\ 5^h\cdot6\ e$. Period $12^d\ 22^h\cdot1$.

NOTE.—I continue to use Greenwich Mean Time, as this is more suitable for use in astronomical records. To convert into Summer Time, add one hour to all times given above. For example the occultation disappearance of 87 Virginis occurs at $9^h\ 0^m$ *e* Summer Time. (See Table 36.)

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE SPECTRA OF THE STARS.—*The Proceedings of the National Academy of Sciences* contain some important articles from Mount Wilson Observatory. It has been suspected for some time that the character of a star's spectrum varies according to its absolute luminosity. Mr. W. S. Adams has found such a criterion in the relative intensities of lines due to different substances. Thus the hydrogen lines are compared with those due to iron and calcium. It is found that the ratio of intensity for certain lines follows the type of spectrum in the Harvard scale with fair exactness. These lines give no indication of the star's absolute luminosity. But there are other lines that do vary with the star's luminosity. The best lines for the purpose are found to be the calcium line at 4455 and the strontium line at 4216. The brighter the star in absolute light, the stronger is the strontium line relatively to the calcium one. The difference appears to be due to temperature, for the same lines that are strong in cool stars are strong in sun-spots, and *vice versa*. The spectra of all stars whose distance is fairly well determined, and whose absolute luminosity is therefore known, were examined, and data secured which enable the absolute luminosity of a star to be deduced from its spectrum. The absolute magnitude is taken to be the magnitude at a distance of ten parsecs, or thirty-two light-years. Comparison with the star's actual magnitude gives its distance. As a test, the distance of each of the stars employed is deduced from the formulae obtained; the agreement with the distance previously adopted is remarkably close. The most serious discordance is in Delta Eridani, whose parallax is ″·19 by the old method, ″·05 by the new. There may thus be occasional failures, but on the whole the new method seems to be a very powerful one, and to give good hope of greatly extending the list of stars whose distance is approximately known. Determination of distances by parallax breaks down for distances beyond fifty parsecs; but the new method is independent of distance, provided the star is bright enough to give good spectrograms.

Mr. Adams has also found a method of distinguishing the giants from the dwarfs in stars of type M. The dwarfs have very weak hydrogen lines, but the giants have hydrogen lines of the same intensity as those of type G, though in other respects their spectra belong to type M. The result is a striking confirmation of Professor Russell's conclusion, reached from an entirely different line of evidence, that the M stars are divided into two classes: the Giants, with absolute magnitude ranging from − 1 to + 3; and the Dwarfs, whose absolute magnitude is 9 or 10. In M stars the hydrogen lines may be used in addition to the calcium and strontium lines as an index to absolute magnitude, and hence to distance.

The new methods indicate a star which is likely to prove one of our near neighbours. It is 6129 in Boss's Catalogue. A parallax of ″·23 is found from the spectrum. Its distance has not yet been measured directly, but the star has been put on the working list at several observatories.

Another interesting spectroscopic result has been announced from Mount Wilson by Messrs. Shapley and Adams. It is that some of the Cepheid and Cluster variables change their spectral type in the same period as the change of light. RR Lyrae changes its spectral type from A at maximum to F at minimum in thirteen and a half hours; while in the same period its magnitude changes from 6·8 to 7·7, and its radial velocity from forty-seven to ninety-one kilometres per second. It is concluded from the change in spectrum that the change in temperature at the radiating surface amounts to 3000° centigrade.

A later paper announces that Delta Cephei itself (which gives the name to the class) changes its spectral type, being F4 at maximum and G2 at minimum. The former is about midway between Procyon and the Sun; the latter between the Sun and Arcturus (nearer the former). This is confirmed by the fact that the photographic change of magnitude is greater than the visual, indicating that the star gets redder at minimum.

The method of finding the absolute magnitude by relative strength of different spectral lines has been applied to Delta Cephei. It gives absolute magnitude 0·7 at maximum and 1·8 at minimum. The actual change of light is 0·8 magnitude, which agrees fairly well with that deduced from the spectral changes. The distance of Delta Cephei would appear to be some sixty parsecs, or two hundred light-years.

THE TOTAL SOLAR ECLIPSE OF LAST FEBRUARY.—A party of ten gentlemen observed this eclipse from Barquisimeto, Venezuela, and have published their observations in a pamphlet of twenty-seven pages, "Nuestra contribucion á las observaciones del Eclipse Total de Sol visible en Barquisimeto." Their instruments were a theodolite, a camera with Goerz anastigmatic lens, and binoculars. The weather appears to have been perfect. They state that a coronal ray, three solar diameters in

length, was visible on the east side, and there was a fine prominence, some two hundred thousand kilometres in height, to the north-west of the disc. Eight small-scale photographs are reproduced, of which six were taken during partial eclipse. One is a very brief exposure during totality, showing the prominences and inner corona; the other was a somewhat longer exposure, showing the corona to a height of about a solar radius. It appears to be of intermediate type, showing some flattening at the Sun's poles, but less than at a time of minimum sun-spots. The points of the compass are not indicated on the diagram; but on the right-hand side, which I take to be the west, there are the bases of four coronal rays and indications of a fifth in high solar latitude. On the left side there is a single ray near the solar equator. Between the rays the corona is visible to a height of half a solar radius, somewhat more near the equator, somewhat less near the poles. The light during totality was sufficient to enable large print to be read. Totality lasted two minutes forty-seven seconds, and ended at 11h. 14m. 11s., local time, at which time the "shadow bands" were visible. They were moving from east-north-east to west-south-west, the opposite direction to the Moon's shadow. The thermometer fell 4° centigrade during totality, being 27° before and after the eclipse, 22° at totality. This was in the sunshine. The shade thermometer fell 2½°. The observers are to be congratulated on doing their best with limited resources to obtain a record of this striking phenomenon. It is to be lamented that such excellent observing conditions could not have been utilised by some astronomer with more powerful instruments.

WOLF'S COMET.—The second comet of the year promises to be an interesting one. It was found by photography, and as it had a well-defined stellar nucleus it was at first taken for a minor planet. Its cometary character was detected after some days, and the following parabolic elements have been calculated by Berberich: Date of perihelion, 1917, June 15·916, Greenwich M.T.; longitude of ascending node, 183° 15′; arc from node to perihelion, 120° 30′; inclination, 25° 35′; perihelion distance, 1·68987 astronomical units. If this orbit is correct, the comet was discovered fourteen months before perihelion—an even longer interval than the ten months in the case of Delavan's Comet found at the end of 1913. The comet when discovered was near the orbit of Jupiter, and was of the thirteenth magnitude. The perihelion distance given above is too great to lead us to expect a very fine display at perihelion, though it is probable that the comet will become visible to the naked eye. It must be remembered that from the distance and slow motion of the comet the orbit is still subject to some uncertainty, and we may hope that the perihelion distance will prove to be less than that given. An interesting fact is that the plane of the orbit is very close to the celestial equator, so that its declination will remain small throughout the apparition. Its present place is in Virgo in a region rich in nebulae, which increases the difficulty of finding such a faint and slowly moving body. It will be an evening star till November 1st, its distance from the Earth remaining nearly constant till then at about four and a half units. It will become observable as a morning star early in 1917. The following outline ephemeris may be of interest:—

	Right Ascension.	Declination.	Log. Sun.	Dist. from Earth.
	h m. s.	° ′		
1916, July 19	12 38 53	4 9 N	0·6255	0·6484
Aug. 7	12 50 29	3 13 N	0·6071	0·6562
Dec. 5	15 17 0	5 27 S	0·4667	0·5755
1917, Feb. 3	17 10 56	4 57 S	0·3785	0·4378
June 16	22 19 32	22 50 N	0·2278	0·0894

MARS.—Two interesting notes on this planet, by M. E. Antoniadi, were read at the May meeting of the British Astronomical Association. The first drew attention to the notable changes of width in the well-known marking Syrtis Major at different times. He has combined the observations at many oppositions, and grouped them according to the Martian season. He then finds that the changes of width appear to be a fairly regular seasonal effect, and to recur at intervals of a Martian year. The other note referred to the rate of meltin of the polar caps in different years. The evidence supported the conclusion that the cap melts quickly when sun-spots are numerous, and slowly when they are scarce, thus suggesting that the Sun is hottest when most spotted. Mr. Maunder said in reference to this that we should expect Martian weather to be much simpler than that on Earth, owing to the thinner air, the scarcity of cloud, the weakness of aerial currents, and the absence of oceanic circulation; hence it would not be surprising that a correlation with sun-spot changes might be noted in its weather more readily than in our own. The British records fail to show any correlation, but traces have been suspected in those of the United States and India. It is to be hoped that the study will be continued on Mars, as the suggestion is a very interesting one. The polar cap is such an easy object that its size could be measured, even when Mars was too distant for any other work to be done upon it.

At the same meeting Mr. Maunder showed a photograph of the great group of sun-spots which passed the central meridian about May 25th. It was one hundred thousand miles long, and contained several separate umbrae. It was one of the finest groups ever photographed at Greenwich.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

EMBALMING AGENTS USED BY THE INCAS.—Two resinous masses which had been used by the Incas of Peru for embalming their dead have been examined by M. L. Reutter (*Comptes Rendus*, 1916, CLXII, 689). They formed a yellowish brown powder, consisting of resins enclosing fragments of woody fibre and vegetable tissue. Chemical analysis showed that they were composed of tolu, or Peru balsam, mixed with salt and vegetable matter rich in tannin and essential oils. They were thus very similar in composition to the embalming substances used by the ancient Egyptians, which consisted of Judaean bitumen, storax, turpentine resins, and sodium carbonate; and to those of the Carthaginians, which contained Judaean bitumen, storax, turpentine resins, and vegetable matter rich in essential oils, especially those containing menthol and thymol.

PERMANENCE OF WRITING INK.—A paper by Mr. D. B. Dott, dealing with the fading of ink in writing, is published in a recent issue of *The Journ. Soc. Chem. Ind.* (1916, XXXV, 493). In order to obtain some idea as to the comparative permanency of different samples of ink when exposed to the air, tests were made by applying dilute hydrogen peroxide under constant conditions to specimens of writing done with the inks. Meanwhile, the paper was exposed to the light, and a note taken of the time which elapsed before the characters disappeared. It was found that ferric tannate, aniline blue, and indigo were all rapidly decolorised when warmed with three-per-cent. hydrogen peroxide. The violet ink used with typewriters was less readily bleached, but disappeared when treated with sulphur-dioxide solution. The only inks that were found capable of resisting both reagents were those containing finely divided carbon in suspension.

The objection to this method of testing inks for permanency is that the conditions of treating writing with a solution of a powerful oxidising or reducing agent are by no means the same as those to which the writing will be exposed under ordinary conditions. This is shown by the fact that there are specimens of writing many centuries old which show as rich a tone as freshly written documents, and yet these would be rapidly bleached if treated with warm hydrogen peroxide or sulphurous acid.

Although carbon in a finely divided state has the property

of giving writing which will resist chemical reagents, inks which contain it do not, as a rule, penetrate into the fibres of the paper, and can usually be washed off the surface when gently rubbed with a brush beneath the surface of water or alcohol. On the other hand, the ordinary writing ink penetrates deeply into the paper, and cannot be removed mechanically without spoiling the surface of the paper. For important purposes, therefore, a well-made iron-gall ink is preferable to any ordinary carbon ink, and such ink is required to be used for documentary purposes in Germany and in some of the American States.

The main essential for an iron-gall ink is that it shall contain the correct proportions of tannin and iron, and if this be the case the writing done with it will resist all ordinary conditions of oxidation or reduction caused by air or light. Where writing has faded to a faint yellow or brown it may be assumed with great probability that the ink contained too little tannin or iron, or that the proportions of these were not correct.

GEOLOGY.

A COMPOSITE GNEISS IN IRELAND.—In the current volume of *The Quarterly Journal of the Geological Society* Professor Grenville Cole describes the occurrence of a composite gneiss near Barna, County Galway. In this area there is a great mass of granite, probably of pre-Cambrian age, intruded into the schists which here form the country rock. The normal granite is porphyritic, containing large crystals of pink orthoclase, often as much as ten centimetres long, and was intruded at a time when the schists were under stress and in motion, so that tongues of the igneous rock penetrated for considerable distances along the foliation planes of the schists. Some solution of the country rock in the granite took place, and the latter became enriched in biotite derived from the hornblende and biotite of the schists, which were altered in turn, their titanic oxide being converted into sphene in place of rutile. The large felspars were carried into the fissures along with the magma, and in some cases lines of them are found along the foliation planes of the schists, all the magma having been, so to speak, soaked up by these, forming a composite rock, and leaving only the porphyritic crystals unabsorbed. This phenomenon has been observed in other places, notably in Brittany, where the Granite de Rostrenen invades mica schists, and near Cape Town, where the Table Mountain granite is intruded into the Malmesbury series. In both cases porphyritic felspar crystals are found in the sediments, which were originally referred to crystallisation in place of granite magma which had diffused into the sediments; but the theory of their injection with molten rock, which has since been absorbed, now seems to be the more probable.

W. H. W.

THE GEOLOGY OF MESOPOTAMIA.—From the geological point of view, Mesopotamia is a fairly well-defined region. It lies partly on the outer side of the Iranian mountain chains and partly in the angle between these and the Tauric arc. These chains are overthrust towards the south-west and south; hence Mesopotamia forms a transition zone between the folded mountain chains of south-western Asia and the great desert plateau of Arabia. The solid rocks consist for the most part of Upper Cretaceous, Eocene, and Miocene strata, dipping generally in a south-easterly direction. The upper courses of the Euphrates and Tigris near the foot of the mountains pass through a hilly country, composed of Miocene strata, with rock-salt and gypsum, with a covering of basaltic lava-flows. North of the proposed line of the Bagdad Railway is a much dissected area of Eocene limestone, with coal and basalt. In the angle between the Iranian and Tauric arcs is a great volcanic centre—the Karadja Dagh, now extinct. The eruptions evidently belonged to the same phase of volcanic activity as the Tertiary eruptions of Europe. In the region between the great rivers, in Mesopotamia proper, the solid rocks are covered by a great thickness of alluvium, chiefly mud and sand, with few pebbles. This passes down into a long and narrow delta, which is rapidly extending itself seawards into the Persian Gulf.

R. H. R.

CORUNDUM IN IGNEOUS ROCKS.—Corundum is not, so far as is known, a common constituent of igneous rocks: it is found in some nepheline syenites, for example, and in these it may be due to the crystallisation of a magma unusually rich in alumina. Perhaps the most famous occurrence, however, is in the well-known Sapphire Dyke in Montana, where the corundum is almost certainly due to the absorption of fragments of sediments. Examples of a similar kind in Scotland have been described by the Geological Survey. Mr. H. G. Smith has recently described before the Geological Society a small lamprophyre dyke at Lurgecombe Mill, in Devonshire, containing corundum, probably derived from partly digested fragments of sedimentary inclusions. Although the mineral was first detected in a slice, it is interesting to note that further investigations were carried out by crushing the rock and separating the powder in heavy liquids. This is a method of much promise in work of this kind, and in the search for the rarer minerals of all kinds of rocks it is likely to yield much more trustworthy results than the customary simple microscopic examination of thin slices. There is no doubt that much remains to be learnt about the accessory minerals of the igneous rocks in general.

R. H. R.

THICKNESS OF BRITISH SEDIMENTARY ROCKS.—One of the greatest difficulties of the stratigraphical geologist has always been to obtain reliable information as to the thickness of any particular rock-series in different parts of the country. This knowledge is almost essential in any work involving generalisations and conclusions as to the physical and geographical conditions of the past. The Geological Survey of England and Wales has recently published a special memoir, entitled "Thicknesses of the Strata in the Counties of England and Wales," which will be invaluable from this point of view. As the title implies, the arrangement is geographical, and there are many small maps showing the exact position of the places where the measurements have been made. It is but seldom that a direct measurement can be made in an actual exposure, apart from cliffs, and the most valuable records inland come from wells and borings. In using these it is, however, necessary to ascertain whether the boring passes through the whole formation. If it starts in the middle of one series and stops in the middle of another, as is so often the case, the figures may be quite misleading; hence no doubt many under-estimates have arisen. In this memoir attention is confined to formations above the Carboniferous, and wisely so, since our knowledge of the real thickness of the Lower Palaeozoic rocks is still very incomplete.

R. H. R.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

PERSISTENCE OF WET AND DRY WEATHER.—At the meeting of the Royal Meteorological Society on April 19th Mr. E. V. Newnham read a paper on "The Persistence of Dry and Wet Weather." He has examined the rainfall records of Greenwich, Kew, Aberdeen, and Valencia in order to find out how often rain falls on the day following successive runs of one, two, three, and so on, wet or fine days. The current notion seems to be that after a long run of wet days the chance of a fine day becomes greater, but statistics do not support this conclusion. Generally speaking, the expectation of rain on any day has been found to increase rapidly as the number of previous wet days increases, and to diminish with the number of successive fine days in the past. After very long spells of either kind the expectation of further rain reaches a practically steady value. The same conclusion holds for the expectation of rain in a given hour after different runs of wet and dry hours. In illustration, some of the results

XUM

may be quoted. At Valencia, after seven days of drought, rain falls on the eighth day twenty-four times out of one hundred, but after seven rainy days eighty-six times. For Kew the corresponding increase is less, namely, twenty-seven to seventy-three.

REÄDJUSTMENT OF PRESSURE DIFFERENCES.—At the meeting of the Royal Meteorological Society on May 17th Mr. L. C. W. Bonacina read a theoretical paper entitled "On the Reädjustment of Pressure Differences: Two Species of Atmospheric Circulation and their Connection." He began by presenting a résumé of our knowledge relating to cyclonic and thunderstorm circulation. He considered that storm-action must be in either case initiated by slight variations of density, the disturbances being of a cyclonic or of a thunderstorm type, according to whether they are mainly in a horizontal or in a vertical direction. He attempted to explain the conditions which determine the type of disturbance, and advanced a theory of wave-transmissions which he hoped to test by application to observed facts.

In the discussion which followed the reading of this paper nearly all the speakers expressed themselves as not in agreement with the views of the author.

ROYAL OBSERVATORY, GREENWICH.—The Board of Visitors of the Royal Observatory, Greenwich, held their annual visitation on June 3rd, when the Astronomer Royal presented his report on the work for the year. The principal features of interest in the meteorological conditions during the year ending April 30th, 1916, are (1) the warm January, with a mean temperature 2° higher than any January from 1841 to 1915; (2) the great pressures of wind in the gales in the winter; and (3) the heavy rainfall in March, the wettest March since the commencement of the Greenwich records in 1841. The rainfall for the twelve months was 32·17 inches, or 8·05 inches above the average. June, with 0·56 inch, was the driest, and December, with 5·20 inches, the wettest month. The duration of bright sunshine registered was one thousand four hundred and seventy six hours. This was below the average, principally owing to a deficiency in August and March.

The mean values of the magnetic elements for the last five years are as follows:—

Year.	Declination.	Horizontal Force in C.G.S. units.	Dip.	
	° ′		° ′ ″	
1911 ...	15 33·0 W.	0·18549 ...	66 52 6	(3-inch needles)
1912 ...	15 24·3	... 0·18548 ...	66 51 46	,, ,,
1913 ...	15 15·2	... 0·18534 ...	66 50 27	,, ,,
1914 ...	15 6·3	... 0·18518 ...	66 49 27	,, ,,
			66 51 13	(dip inductor)
1915 ...	14 56·5	... 0·18494 ...	66 51 58	,, ,,

REMARKABLE "SEEING" QUALITY OF THE ATMOSPHERE AT KASHMIR.—In the report on the administration of the Meteorological Department of the Government of India in 1914–15 Dr. G. C. Simpson, the officiating Director-General, says that it is a well-known fact that it is the unsteadiness of the atmosphere, and not the power of the telescope, which ultimately limits the possibility of seeing the finest details of the heavenly bodies. In 1913 Mr. Evershed, the Director of the Solar Observatory at Kodaikanal, spent his privilege leave in Kashmir, and while there he was very much struck by the great homogeneity of the atmosphere, which made it possible to see the surface structure of the Sun and planets with extraordinary distinctness. Solar work depends so largely on the ability of seeing the finest markings of the Sun's surface that the Government of India deputed Mr. Evershed to visit Kashmir during May to July, 1914, to carry out further investigations on this unexpected quality of the atmosphere over the Kashmir Valley. The photographs of the Sun taken on this expedition and the careful record kept of the "seeing" at all hours of the day have proved conclusively that, so far as is known, no other place in the world can compare with Kashmir in this respect. The discovery is so important that a further expedition to Kashmir with more powerful instruments and for a longer period has been sanctioned, and will take place during 1915–16.

MICROSCOPY.

By F.R.M.S.

A FUNGUS ON CHERRY LAUREL (*CEUTHOSPORA LAUROCERASI*).—An examination of the fallen leaves of *Prunus Laurocerasus* (the cherry laurel) and the dead twigs of the same shrub produced in the preceding season will show that they often bear a number of flat round black patches, about one millimetre in diameter or less (see Figure 119), which are frequently marked in the centre with a little protruding pore (or sometimes several pores) from which a whitish powder at length exudes (see Figure 120). These round discs, on microscopical examination, will be found to contain large numbers of minute curved (sausage-shaped) spores, which are colourless, and

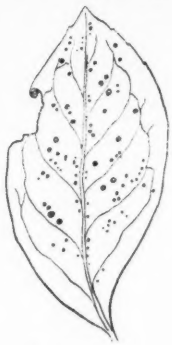

FIGURE 119.
Leaf of Cherry Laurel with the fungus *Ceuthospora*—half natural size.

FIGURE 121.
One of the *Cytospora* pustules × 15.

FIGURE 122.
Spores of *Ceuthospora Laurocerasi* × 500.

FIGURE 120.
One of the *Ceuthospora* discs × 15.

FIGURE 123.
Spores of *Ceuthospora Euonymi* × 500.

measure about five to seven μ long (see Figure 122). In 1827, in the Scottish Cryptogamic Flora, this fungus was named by Greville *Ceuthospora Lauri*, and illustrated in Plate 254. In his description he states it to be on "the common laurel (*Laurus nobilis*)," but as he gives an excellent figure of the leaf we can see that it belongs to *Prunus Laurocerasus*, not to *Laurus*.

On similar leaves and twigs of the cherry laurel there will also be found, at times, a fungus of a slightly different external appearance, showing as smaller conical black sub-epidermal pustules (see Figure 121), which burst through the outer surface and are pierced by a pore at the summit. But the spores will be found to be *identical in shape and size*. This second form was named by Fuckel, in 1860, *Cytospora Laurocerasi*, it being supposed that the two were different species of fungi.

Now, on the leaves and twigs of *Euonymus japonicus* there has been found a similar species, with very different spores (viz., straight and nearly three times as long) (see Figure 123), to which the name *Ceuthospora Euonymi* has been given. This fungus has both the forms mentioned above growing intermixed, and gradually shading into each other, with the same spores throughout, so as to show,

FIGURE 124. Fine Pottery: Nicoya, Costa Rica.

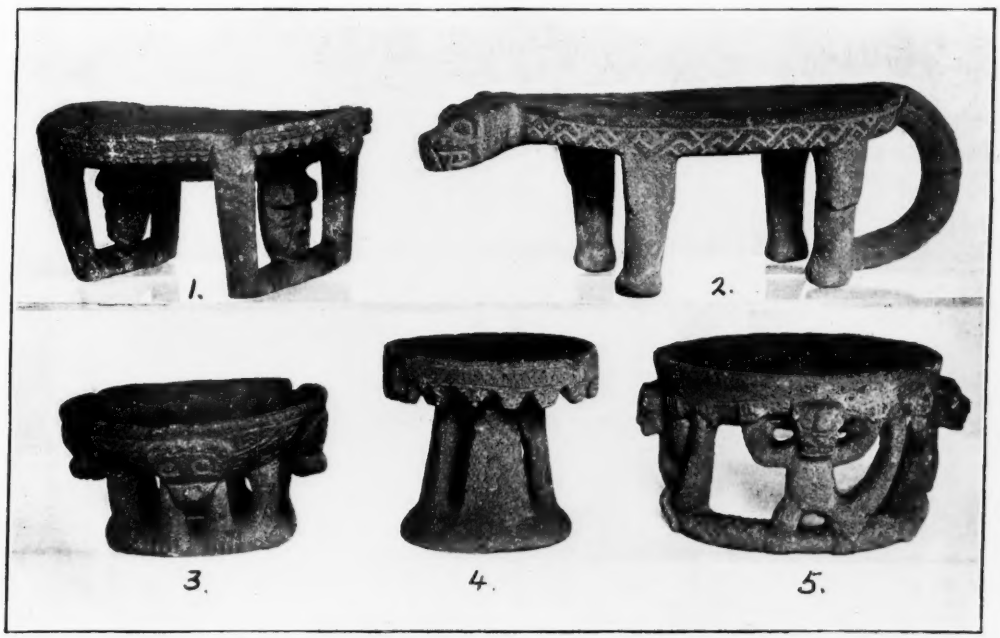

FIGURE 125. Stone Stools and Metates: Guetas, Costa Rica.

FROM "CENTRAL AMERICAN ARCHAEOLOGY." (See Page 151.)

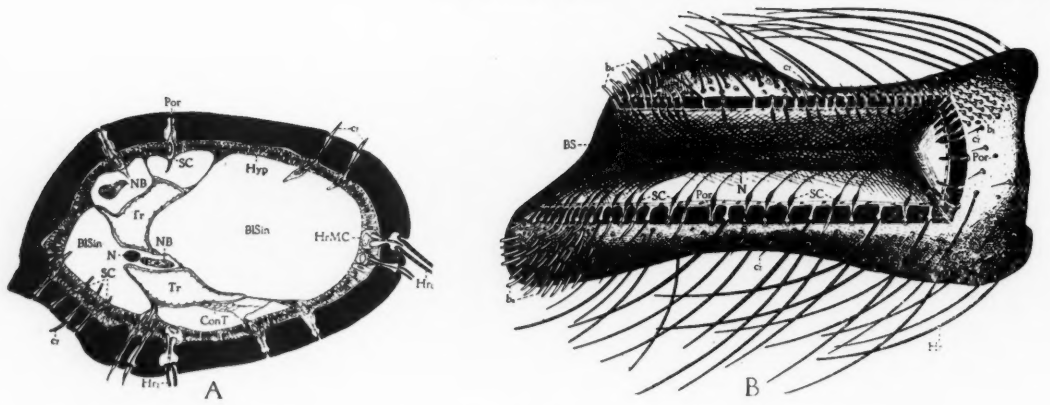

FIGURE 126.

Internal anatomy of mandible of a worker honey bee, showing how well this appendage is innervated.

A, semi-diagram of cross-section through middle of mandible, showing innervation of olfactory pores (*Por*) and tactile hairs (C_7), blood sinuses (*BlSin*), nerve (*N*), nerve branches (*NB*), tracheae (*Tr*), and so on. The details of the hypodermis (*Hyp*) were taken from another section ×185. B, diagram of transverse-longitudinal view of mandible, showing innervation of olfactory pores (*Por*) and tactile hairs (b_1, b_4, and c_7) and superficial appearances of these sense-organs. The hairs in solid black are not innervated, while all the others are connected with sense-cells (*SC*).

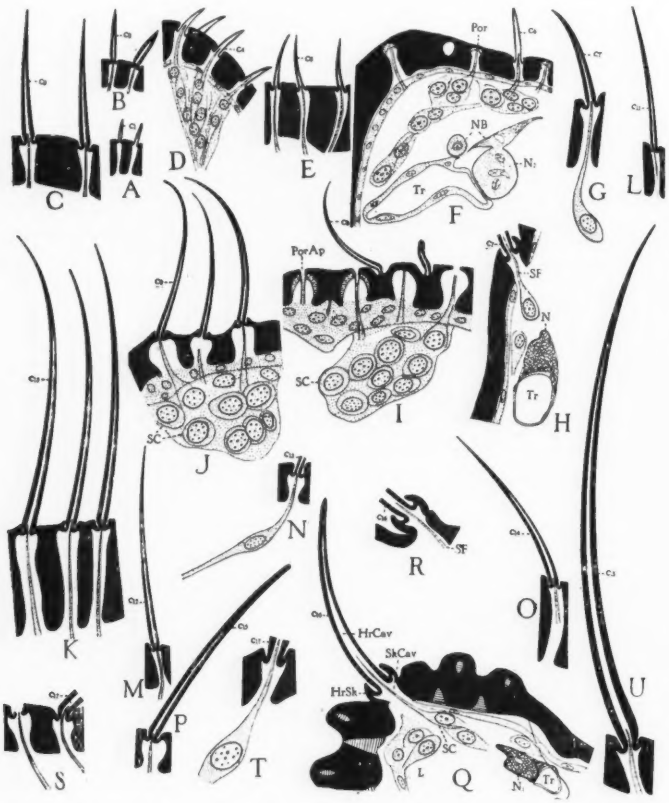

FIGURE 127. Internal anatomy of spine-like, innervated hairs of worker honey bees ×580.

A, smallest and B, largest of these on flagella of antennae; C, from base of scape of flagellum; D, from maxilla; E, from maxillary palpus; F, from labial palpus; G, from proximal end of mandible; H, from base of paraglossa; I to K, from cervical plate; L, from just inside of median line on top of head, over pharyngeal plate; O, from palpiger; P, from side of mentum; Q, from middle of glossa, the hair being from a whole mount and the hair-socket (*HrSk*) from section; R, from tip of glossa; S, from dorsal and T, from ventral surface of labrum; U, from tip of maxilla. All these hairs were taken from pupa and imago workers of various ages.

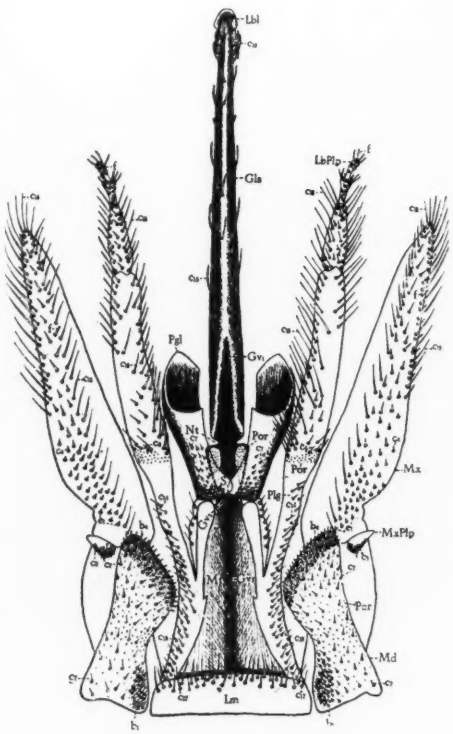

FIGURE 128. Diagram of mouth-parts of a worker honey bee spread out flat, showing disposition of innervated hairs

(b_1, b_4, c_4 to c_7, c_{14} to c_{15}, *e* and *f*) and olfactory pores (*Por*) on dorsal surfaces of glossa (*Gls*), paraglossa (*Pgl*), palpigers (*Plg*), mentum (*Mt*), and labrum (*Lm*) on inner surfaces of labial palpi (*LbPlp*) and on outer surfaces of maxillae (*Mx*), and mandibles (*Md*) ×25. All the hairs shown are innervated, and the pseudo-hairs on the glossa have been omitted.

SENSE-ORGANS ON MOUTH-PARTS OF BEE after McINDOO.

Smithsonian Miscellaneous Collections, Volume 65, Number 14.

evidently, that they are merely states of the same species. A little study of the mode of occurrence of these two forms makes it probable that the *Cytospora* form is that adapted to rapid multiplication, while the hard, flat, dense discs of the *Ceuthospora* form act as a kind of resting stage, which can last through the unfavourable period of the year without injury. What is true of *Ceuthospora Euonymi* is plainly true also of the fungus on the cherry laurel. The occurrence of these two forms of spore-bearing structures is the distinguishing mark of the genus *Ceuthospora*.

The only other British fungus of the genus is the so-called *Ceuthospora phacidioides*, the black, flat, shining discs of which are exceedingly common on dead leaves of holly, less often on the twigs. They resemble those of the cherry laurel fungus, but are frequently barren; when they do contain spores, these will be found to be similar to those of *C. Euonymi*, but more variable, and usually wider. This holly fungus is known to be merely a pycnidial stage of the Discomycete, *Phacidium multivalve*, which can be found, more rarely, on the same leaves. In the same way the other two Ceuthosporas *may* be stages of some other fungus, but as yet nothing is known upon this point.

The question then arises, Which of the two given names shall be adopted for the cherry laurel saprophyte? According to the rules, *Lauri*, being the earliest specific name, must be retained. But the "Vienna Rules of Botanical Nomenclature" have lost a little of their glamour since August, 1914. A Hunnish docility and obedience to regulations, *as* regulations, has fallen of late somewhat into disrepute. In Greville's time *Prunus Laurocerasus* was known in Great Britain as *the* laurel (*Aucuba japonica* not having become so familiar then as now), and anyone who knows how widespread the error is in this country will not be surprised to find that Greville imagined it to be *Laurus*, the bay, or laurel of the ancients.

But there appears to be, according to the books, a species of *Ceuthospora* found on the true bay laurel in Italy, which has not yet occurred anywhere in Britain. For this, obviously, the name *Ceuthospora Lauri* would be appropriate, and Greville's species should be named, for distinction, *Ceuthospora Laurocerasi*. Why should one use a misleading name (it *has* misled many foreigners) merely in obedience to a dogma? Common sense, as understood among men of the world, dictates that a false name, given in error, carries no rights of priority. To maintain the contrary is merely to make a fetish of uniformity. W. B. GROVE, M.A.

TASTE AND SMELL IN THE HONEY-BEE.—Little has been done to show that insects have a true sense of taste, and Dr. McIndoo has set himself to remedy this defect (*Smithsonian Miscellaneous Collection*, Volume LXV, Number 14). His experiments show that bees, besides being able to smell, must be able to taste, because they may begin to eat food which they dislike. Dr. McIndoo concludes that their faculty to discriminate between foods is greater than ours, for they could distinguish differences which he could not. As a rule, foods agreeable to us were also agreeable to bees, but there were some marked exceptions. All foods scented with peppermint (according to Dr. McIndoo) are pleasant to us, but they were repellent to bees. Dr. McIndoo says that he does not care for candy containing potassium ferrocyanide, but bees are rather fond of it, and it does not seem harmful to them. To prove the conclusion that bees really taste, it was necessary to show that the mouth-parts possess sense-organs fitted for receiving gustatory stimuli. Dr. McIndoo found two types of sense-organs (see Page 146), innervated hairs, and innervated pores (Figure 126 shows the latter and Figures 127 and 128 the former). These appear to serve only as tactile organs. The pores Dr. McIndoo terms "olfactory pores." We know ourselves that it is almost impossible to say whether we taste or smell certain substances when we eat them. Sometimes a food before being eaten emits only a faint odour, or none at all. When we eat it we notice a pronounced odour. The same principle is applicable to bees, and the gustatory sense in insects is only a phase of the olfactory sense.

ROYAL MICROSCOPICAL SOCIETY (President: Mr. E. Heron-Allen, F.L.S.).—At a meeting of the Royal Microscopical Society, held on Wednesday, June 21st, Miss G. Lister, F.L.S., made a communication on the life-history of Mycetozoa, with special reference to *Ceratiomyxa*, in which she referred to the work of Dr. Jahn, of the Berlin University, proving that the amoebulae produced by division of the swarm-spores united in pair as gametes to produce zygotes, from which the plasmodia grew. The nuclei of the zygotes had twice as many chromosomes as the nuclei of the gametes. In *Ceratiomyxa* Dr. Jahn was the first to observe the division of nuclei in the young sporophores prior to spore-formation. This was found to be a reduction division, and took place during the "network" stage of the maturing sporophore. To illustrate these observations lantern slides, taken from the preparations lent by Dr. Jahn, were shown on the screen, as well as a series of slides showing the more striking forms of sporangia met with among the Mycetozoa. Microscopical preparations and drawings illustrating the development of *Ceratiomyxa* and other Mycetozoa were exhibited by Miss Lister, and also a number of drawings and specimens of the principal genera. Other illustrative preparations of Mycetozoa were shown by Messrs. Hilton and Huish.

PHOTOGRAPHY.

By EDGAR SENIOR.

The "HYPO"-ALUM TONING METHOD.—The only direct process of sulphide toning that can be said to have been employed to any extent is that in which a mixture of "hypo" and alum is made use of, and this can nearly always be relied upon to give good tones when the operations are properly carried out. When alum is added to a solution of "hypo" a white precipitate is gradually produced, varying with the temperature and the time that has been allowed to elapse since the mixture was made. At first the precipitate consists of aluminium hydrate and sulphur in nearly equal proportions, but after some time the sulphur greatly preponderates. The toning process is therefore due to the agency of sulphur. Various formulae for the toning bath have been given by different workers, but the following will be found to be one that will enable rich brown and sepia tones to be readily obtained on bromide paper:—

Thiosulphate of soda ("hypo") ...	3 ounces
Water	20 ,,
Ground alum	140 grains

In making up the above solution the "hypo" should be dissolved in the water first, and the alum then added in small quantities at a time, stirring during the operation. The solution should then be allowed to stand for two or three days, after which it is heated to about 130° F. for an hour or so, with some waste bromide prints in it, in order to bring about what is known as "ripening." If the bath is not sufficiently "ripened," the prints will be considerably reduced, and only yellowish brown tones obtained. When required for use the "hypo"-alum solution should be divided into two equal parts, one of which should be heated to from 90°–120° F., while the other is kept perfectly cold. The prints to be toned are first put into the cold solution, and then transferred directly to the hot one, in which they will tone in from twenty minutes to half an hour or more, the time depending upon the temperature, the kind of paper used, the method of development, and so on. It is generally considered that prints that have been developed with amidol, tone most readily by this method. The results that are obtained will depend upon the nature of the print. For rich brown tones it is necessary that the print should be decidedly too dark and heavy for a black print, and that the bath be thoroughly "ripe." After toning the prints are rinsed in a tepid solution of:—

Alum	275 grains
Water	20 ounces

They are then thoroughly washed in running water. Although the quickest results are obtained by employing

the "hypo"-alum bath at as high a temperature as the gelatine film will stand, many people prefer to use it at the ordinary temperature of the atmosphere. The toning, of course, takes much longer, usually hours instead of minutes, but the prints require little or no attention, so long as care is taken to remove any air bells from their surface, and they are kept thoroughly immersed in the solution. Some twelve hours or so are about the usual time occupied in toning in warm weather. A short time longer than appears necessary will, however, do no harm, as, beyond a certain point, all further action appears to stop. One point, however, must not be lost sight of: prints toned in a cold solution are reduced in strength more than those toned in a hot one; they must therefore be developed to a darker stage.

POTASSIUM PERMANGANATE AS A REDUCING AGENT.—The use of potassium permanganate in the sepia toning of bromide and similar prints, to which we recently drew attention in these columns, further reminds us of its utility as a reducing agent for negatives, for which purpose it was originally recommended by Professor Namias in 1899. Although the method does not appear to have been used to any extent, it is well worth attention, since it is both effective and cheap; while the solution keeps very well, and can be employed for negatives that have not been thoroughly washed to eliminate, so far as possible, all the "hypo." The acid solution of potassium permanganate that forms the reducing agent acts in a manner analogous to that of ammonium persulphate, the reduction being proportional to the amount of silver forming the image in the film. The formula for the acid solution is as follows:—

Potassium permanganate	...	4 grains
Water (distilled) ...	...	18 ounces
Strong sulphuric acid ...	...	8 minims

The negative that requires reducing is placed in a porcelain dish and the solution poured on, the dish being kept rocked during the time of immersion. The progress of reduction is watched by examining the negative from time to time, and when it is considered to have proceeded sufficiently far the film is well washed. The action of the reducer will be found to have imparted a brown coloration to the gelatine, due to manganese dioxide deposited from the decomposition of the permanganate. This, however, is readily removed by placing the negative for a few minutes in a one-per-cent. solution of oxalic acid, when, after a final wash, the negative is placed to dry. This reducer also answers well with collodion negatives, the formula recommended in this case being as follows:—

Potassium permanganate	...	3·5 grains
Water (distilled) ...	...	18 ounces
Strong sulphuric acid ...	...	20 minims

As no stain is imparted to the collodion, the use of a subsequent bath of oxalic acid is not required. Although the method of reduction has given satisfactory results in our hands, some workers have not been successful in its use, they having complained of the opalescent and general dirty appearance of the film after treatment. The opalescence is caused by the lime salts in ordinary water reacting with the oxalic acid to form oxalate of lime, which is precipitated on the film as a white opalescent powder. This, however, may be prevented by the use of distilled water, or removed by means of alum and hydrochloric acid. Stains and a general dirty appearance in the film are also the result of using ordinary water, especially when the negative has been given a long immersion in the permanganate solution. It is better to allow the negative to remain in the reducer for a short time only, and to repeat the operation when necessary after an intermediate washing. In this way a proportionate reduction will be obtained each time. The permanganate reducer is therefore a good one to employ for negatives made on plates which have been correctly exposed, but over-developed, for the particular printing process which is intended to be used, as it does not appear to alter the scale of gradation between the various tones in the image.

DEVELOPING GASLIGHT PAPERS WITH PYRO.—In the development of so-called "gaslight papers," it had become the almost universal custom to employ a mixture of metol with hydroquinone as the developing agent, as this was quick in its action, and gave images of good colour and gradation. Now, however, that metol is practically unobtainable, resort is being made to substitutes and developers of a different character altogether. In the current number of *Portrait*—a monthly magazine published in the United States by the Ansco Company—there appears an article dealing with the development of Cyco papers by means of a pyro developer, two formulae being given for the preparation of the solutions. The first formula is as follows:—

DEVELOPER No. 1.

	(*a*)	
Pyro	... ...	75 grains
Potassium meta-bisulphite	...	7 ,,
Sodium sulphite	... ...	260 ,,
Acetic acid (glacial)	... ...	2 drops
Water	... ...	16 ounces
	(*b*)	
Sodium carbonate	... ...	300 grains
Water	... ...	16 ounces
Potassium bromide, 10 per cent.		3 or 4 drops

For use equal parts of *a* and *b* are mixed together. The development of a print on the exposed paper occupies about one minute. The stain produced is very slight, and the colour and gradation of the image very good. In the second formula the developer is prepared as follows:—

DEVELOPER No. 2.

	(*a*)	
Pyro	... ...	180 grains
Sodium sulphite	... ...	3 ounces (avoirdupois)
Potassium ferrocyanide (yellow prussiate of potash)...	...	30 grains
Water	... ...	16 ounces
	(*b*)	
Sodium hydrate (caustic soda)		60 grains
Water	... ...	16 ounces

For use take one part of *a* and one part of *b* and dilute with two parts of water. About two or three drops of ten-per-cent. potassium bromide should be added to each ounce of developer as well. The development of a print takes from one to one and a quarter minutes, the colour and the gradation of the image being excellent. With this developer staining has been reduced to a minimum, due, it is stated, to the products of oxidation of the developer being taken up by the potassium ferrocyanide. The developer may be used repeatedly without stains being produced, or any appreciable reduction being made in its speed of development. The developer may be modified whenever necessary, diluting it to half its strength, producing much softer results without in any way sacrificing the beauty of the print; and, lastly, very fine results may be obtained in the prints by sepia toning.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

METHOD OF STUDYING RIPPLES.—Watson and Stewhart, in an illustrated article in *The Physical Review* for February, 1916, describe a stroboscopic method of studying ripples. The waves are generated by puffs of air striking the surface of water contained in a glass-bottomed tank. The air-stream is cut up into puffs by means of a rotating perforated disc placed in the path of the tube conveying the air to the surface of the water. An arc lamp is focused on the row of holes in the disc, and thus the wave-pattern appears stationary when illuminated by light which traverses the holes. If it is desired to produce the effect of slowly moving ripples a separate disc, mounted

on the same axis, is used for illumination. If this second disc has slightly fewer or more holes than the disc used to interrupt the air-stream, the patterns produced will appear to have a slow progressive motion over the disturbed surface.

APPLICATION OF THE *X* RAYS TO THE TESTING OF STEEL CASTINGS.—Davey has successfully used *x* rays for the detection of air inclusions in steel castings. Although radiographs can be taken through a thickness of one and a half inches of steel, commercially it is only possible up to half an inch. By using a tube suitable for a voltage equivalent to a fifteen-inch spark gap it is possible to detect an air inclosure 0·021 inch thick in three-eighths of an inch steel. (*American Electrochem. Soc. Trans.*, XXVIII, 1915.)

THE IONISATION AND DISSOCIATION OF HYDROGEN MOLECULES AND THE FORMATION OF H_3.—Under this title Dempster communicates a very interesting paper to *The Philosophical Magazine* for May, 1916. Sir J. J. Thomson has shown that in a vacuum tube containing hydrogen there are present charged atoms, charged molecules, and sometimes a constituent with a mass three times that of the atom of hydrogen. Dempster used the following method of obtaining the positively charged particles to be studied. Electrons were given off from a white-hot cathode, covered with lime, and have their speed increased by traversing hydrogen at low pressure in a high electrostatic field. They ionise the gas, and the positive particles produced acquire a velocity in the opposite direction to that of the electrons. This carries them past the narrow edge of the cathode through a narrow tube. They are then deflected by magnetic and electric fields, and fall on a screen, which has a parabolic slit. Each kind of particle in these positive rays is drawn out into a parabolic curve, and by adjusting the magnetic field the various parabolas may in turn be made to fall on the slit. When this occurs the particles pass through the slit, and the charge they carry can be measured by a Faraday chamber, into which they pass. Dempster found that, with electrons moving with a speed due to a fall of eight hundred volts, the first effect is to ionise the gas by detaching an electron from the molecule. The positively charged molecule so formed dissociates the hydrogen, and the complex H_3 is formed.

PHYSICAL PROPERTIES OF GALLIUM.—The rare metal gallium, discovered by Boisbaudran and named after his country over forty years ago, has recently been found in American zinc ores in what, for gallium, may be regarded as considerable quantities (Hillebrand and Scherrer, *Chemical News*, April 28th, 1916). The metal gallium is very widely disseminated, and is present in commercial aluminium. It is a bluish white metal, which fuses at 30° C. The molten metal possesses the colour of silver, and remains liquid for many weeks at ordinary temperatures, and even when exposed to 0° C. Like many other super-cooled liquids, it will solidify on coming in contact with a small portion of the corresponding solid. The molten metal wets glass and quartz, and covers the surfaces with a mirror. The metal obtained by Hillebrand and Scherrer is alloyed with a little indium and zinc, and this would probably tend to keep it in the liquid form.

THE HIGH-FREQUENCY SPECTRA OF THE ELEMENTS GOLD-URANIUM.—A very interesting paper on the *x*-ray line spectra of the elements of high atomic weight is contributed by Siegbahn and Fiiman, of the University of Lund, to the April number of *The Philosophical Magazine*. Moseley showed how the *x*-ray spectra are simple functions of the order of the chemical elements in the periodic table. The authors investigate the elements from gold to uranium, thus taking up the work at gold which was as far as Moseley's investigation was carried. The work was done by somewhat similar methods. The primary radiation was used, the element being placed as anti-cathode in the *x*-ray tube. The results show that the root of the frequency of the stronger of the two α lines of the L series for each element is a linear function of the order of the element in the periodic table. The places as yet unoccupied in the table in this region, and which we may thus expect to see filled up, are two between bismuth and niton, and one separating the members of each of the pairs niton-radium, radium-thorium, and thorium-uranium.

RADIO-ACTIVITY.

By ALEXANDER FLECK, D.Sc.

ATOMIC WEIGHT OF IONIUM.—O. Honigschmid, who has done much work on atomic weights, has recently turned his attention to the radio-element ionium. Boltwood, Keetman, and Auer von Welsbach have each endeavoured to purify ionium from the thorium associated with it, but without success. Their experiments contributed to a very material extent to the conception of isotopic elements. Honigschmid's work is described in the *Zeitschrift für Elektrochemie*. He first of all redetermined the atomic weight of thorium obtained from sources free from uranium or other elements of the uranium-radium series. His results were 232·150 by the $ThBr_4/4AgBr$ ratio, and 232·152 by the $ThBr_4/4Ag$ ratio. He then separated and subjected to careful purification the material in pitchblende residues having the properties of thorium. The same two ratios gave the values of 231·505 and 231·507 respectively. Assuming the atomic weight of uranium to be 238·2, and consequently that of ionium to be 230·2, these results show that his preparation contains thirty per cent. of the latter element. It is of interest to consider this result with that of Russell and Rossi's experiment to determine the spectrum of ionium. They had an ionium preparation, which they calculated contained thirty per cent. of ionium, and they could find no new lines in the spectroscopic photograph when compared with that of ordinary thorium. The material with which they worked came from pitchblende, so that Honigschmid's work makes it extremely probable that they were correct in their assumption of the ionium content of their preparation. Additional weight is therefore given to the conclusion that the spectra of the isotopes thorium and ionium are identical.

URANIUM ORES.—At the end of 1915 the Bureau of Mines of the United States Department of the Interior issued *Bulletin* 104 on "The Extraction and Recovery of Radium, Uranium, and Vanadium from Carnotite," by C. L. Parsons, R. B. Moore, S. C. Lind, and O. C. Schaefer. The *Bulletin* summarises the different known methods for the extraction of radium, and then describes the method adopted in the factory in Denver, Colorado. A description of the extensive plant erected at that place, which is comparatively near the locality where the ore is worked, is given, and then follows a very complete and detailed account of the actual process in the works. Concluding chapters deal with the refining of the radium-barium material; the methods employed in the measurement of radium; and finally on "Recoveries, Losses, and Cost Data." The whole forms a very useful publication for those working with uranium minerals.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

REFLEX DISGORGEMENT.—When a llama is annoyed it "spits," and in truth it is much more than saliva that it expectorates. At a very distant grade of organisation, among the locusts and grasshoppers, we find the same offensive habit. When one is seized between the fingers it ejects a brownish fluid from its mouth. The phenomenon has been recently studied by Étienne Rabaud. He finds that if the insect be caught by its elytra, or antennae, or head, or abdomen—without pressing on the thorax—the

XUM

disgorgement does not occur. There are various excitable zones, but the thorax is the chief one. The disgorgement is a reflex process, depending on the thoracic ganglia, especially perhaps of the prothorax and mesothorax. The fluid which is disgorged comes from the crop, where the food is in part digested under the influence of salivary and other secretions. Rabaud is very much opposed to what he calls "anthropomorphic biology," and to the idea that sufficient explanation of the curious phenomenon is given if we postulate "a vomiting instinct," and regard the expedient as a quaint mode of defence. An obvious difficulty is that the disgorging does not occur unless the insect is seized in a particular way. Another difficulty is that in some cases the disgorging does not seem to have any defensive effect. When a praying mantis seizes a cricket it may do so in such a way that the reflex is not excited, but if it compresses the thorax there is abundant disgorgement. Yet this makes no difference to the mantis. It is not in the least likely that birds will be prejudiced by the disgorgement. The defensive rôle is very problematical. The disgorgement reflex implies more loss than gain; it is idle to force it into the frame of utility. Perhaps it is but a secondary and unimportant consequence of a functional relation between the thoracic ganglia and the stomato-gastric sympathetic system which is primarily justified in connection with nutrition.

"LEGEND" OF THE YOUNG CUCKOO.—Many attempts have been made to impugn the accuracy of Jenner's observation that the young cuckoo evicts from its foster-parents' nest the rightful tenants, either as eggs or fledgelings. Xavier Raspail returns to the criticism, having been provoked by faked photographs submitted in evidence of what he calls the "legend." His main point is that the young cuckoo is extremely feeble for five or six days after hatching, and could not evict even if it would. The evicting agent is the mother cuckoo. If the mother be accidentally killed after laying, then the young of the foster-parent may be found in the nest along with the young cuckoo. It is admitted that the young cuckoo may eventually crush its co-tenants, but this is simply mechanical, his rapid growth filling up the nest. It is denied that he evicts them.

Raspail notes that the incubation period of the cuckoo's egg is, on an average, eleven and a half days; that the nurture of the young bird takes nineteen days. For thirty-six hours after birth the young cuckoo is so feeble that it can hardly move in the nest, and cannot possibly balance itself. The mother cuckoo is far from being indifferent to her egg; she watches attentively over the incubation. She may pierce the eggs with her bill when there are signs of hatching, but she does not remove them till her own young one is hatched.

Jenner's observations have been corroborated in detail, and, in spite of faked photographs, are still to be accepted. But it does not follow that Raspail is not right also in the positive part of his conclusion, that the very young cuckoo is too weak to eject either egg or nestling, and that the mother cuckoo then interferes. We remember, however, what Alfred Newton wrote: "Of the assertion that the cuckoo herself takes any interest in the future welfare of the egg she has foisted on her victim, or of its product, there is no evidence worth a moment's attention."

PROVISIONING OF THE EGG-CRADLE IN SOLITARY BEES.—So far as is known, solitary bees store food only in the cell or cradle in which an egg is placed. They generally put in a mixture of pollen and honey, but S. Malychev has studied the detailed differences in different types. Some bees use only dry pollen; some give a preponderance to honey. In some cases the provision is fluid, in others pasty. There are some particular adaptations to prevent drying up.

NEW EXPERIMENTS ON FEIGNING DEATH.—Étienne Rabaud has experimented with five myriopods, a spider, and nineteen insects. The immobilisation follows some jar or shock, not a stimulus of the special senses. The jar is most effective on particular regions of the body—the metasternum in some beetles, the tarsus in others, the insertion of the wings in Zygaena, the anterior segments in a millipede (*Leptoiulus belgicus*). A new excitation "antagonistic" to the first puts an end to the immobilisation. Both the immobility and the resumption of activity are the results of reflexes, and may occur apart from the animal's brain. What ensues is a prolonged contraction of the muscles, and then an inhibition of this. The immobile state is sometimes prolonged and sometimes transient. It is sometimes of life-saving significance; in other cases it appears to be unimportant or even detrimental. Further study is needed.

A CRAB'S JOURNEY.—Professor Alexander Meek, who has made many interesting experiments on the migrations of fishes and the journeys of crabs, reports a recent case of the latter. A female crab, marked on December 1st, 1912, at Beadnell (between Alnmouth and Berwick), was recaptured two miles east of Dunbar on April 26th, 1915. It was liberated just after a moult, and the shell had not been cast again during the two years and more that had elapsed. The ripening of the ova had also been postponed.

THE WAYS OF THE COMMON WASP.—Dr. James Ritchie, of the Royal Scottish Museum, has made a very interesting study of the common wasp (*Vespa vulgaris*). The nest, which had six comb-flats, contained four hundred and seventeen worker adults and a queen. The total number of cells was over four thousand. The building work accomplished by three worker wasps each day was rather more than a single cell. At the end of July the death-rate was not less than eighty-five a day. About three hundred and eighty-two cubic inches of earth had to be removed by the wasps in making the underground cavity for the nest. A big nest may produce twenty-five thousand wasps. Attention has often been directed to the routine behaviour of wasps, but Dr. Ritchie notes that when he once blocked an entrance with a pad of cloth saturated with ammonia he found a new exit in the morning. The original entrance was fifteen inches from the nest; the second, opened in sudden emergency, was made at the place where the earth covering was thinnest—immediately above the nest itself.

THE SHACKLETON EXPEDITION.

By ALEXANDER SCOTT, M.A., D.Sc.

THE arrival of Sir Ernest Shackleton on May 10th at South Georgia has simplified the problem of the rescue expedition, as it makes known the situation of the remainder of the Weddell Sea party. According to the account in *The Daily Chronicle* (June 2nd), the "Endurance" entered the pack-ice in December, 1914, to the south-east of the Sandwich Islands, and then proceeded southwards till Coats Land was sighted. New land, connecting the latter with Prince Leopold Land, was discovered, but the ship was unable to reach its base, and was carried north by the ice-drift, finally sinking on November 20th (1915) somewhere to the north of latitude 69° S. The expedition camped on the floes, and endeavoured to reach Deception Island, but was forced to land on Elephant Island, at the north-east end of the South Shetlands. Thence Sir Ernest Shackleton and four others, in one of the ship's boats, made for South Georgia. The Falklands would have involved a shorter sea journey, but the sea conditions in a voyage to the latter

XUM

were likely to be very bad, while there was also the possibility of obtaining a whaler at the former place to rescue the twenty-two men left on Elephant Island. Unfortunately the latter possibility was not realised, but a boat has now been despatched by the Uruguayan Government.

Although none of the original aims of the expedition have been achieved, a number of important contributions to Antarctic geography have been made. The discovery of the "Caird Coast" links up Coats Land with Prince Leopold Land, and therefore proves the connection of the two latter with the Antarctic continent. During its northerly drift the "Endurance" crossed the site of Morrell's "New South Greenland," but as a depth of one thousand nine hundred fathoms was recorded at this place, the existence of land must be held to be disproved and the western extension of the Weddell Sea verified. As the party had to land on the south-west coast of South Georgia, a traverse had to be made over the ice-capped Allardyce Range to the nearest inhabited station, this being the first time that the crossing of the island had been accomplished. In addition to these geographical discoveries, the leader of the expedition is to be congratulated on the magnificent feat of seamanship in crossing seven hundred miles of Antarctic sea in a ship's boat in winter.

A further despatch in *The Times* (June 27th) intimates the failure of the Uruguayan relief ship to reach Elephant Island. Stream-ice was encountered sixty miles from the latter, and pack-ice finally compelled the ship to return when within twenty miles of the island. Although the position of the marooned men must be regarded as very serious, it is not hopeless, as they are almost certain to be able to supplement their food supplies with penguins and so forth. The ice conditions, however, are abnormally bad, and their rescue depends upon the possibility of obtaining an ice-breaker or similar ship in one of the nearer South American ports.

REVIEWS.

ARCHAEOLOGY.

Central American and West Indian Archaeology.—By THOMAS A. JOYCE, M.A. 270 pages. 29 plates. 64 figures. 2 maps.

(Philip Lee Warner. Price 12/6 net.)

Mr. Joyce has given us a companion volume to his "Mexican Archaeology" and "South American Archaeology," and in it he deals in the first place with the peoples of Nicaragua, Costa Rica, and Panama as they were at the time when they came into contact with white men, and also describes the archaeological remains found in their country. In the second place, he treats of the West Indian Islands in the same way.

There is much that is attractive in the handiwork of the men concerned, as will be seen from two of the many excellent illustrations which we are permitted to reproduce in Figures 124 and 125. Like the makers of the Peruvian pots, these other South American people seem to be more skilled in carving and modelling than in drawing. We might mention in passing the large stone monoliths found on the islands and lakes of Managua and Nicaragua.

Many interesting facts are brought together in the book as regards the customs of the inhabitants. Cutting a culprit's hair in Nicaragua, as in Mexico, was regarded as a severe punishment, usually meted out to thieves.

Turning to the West Indies the principal amusements of the Tainan was a ball game, played in a specially cleared court attached to the villages. The ball was made of a black elastic substance, which suggests some variety of rubber. There might be any number of players on the two sides, and the ball was struck alternately by members of each, but not with the hand—the head, shoulder, elbow, or most often the hip and knee being used. If the ball fell "dead," the side whose turn it was to strike, lost a point. Both men and women took part in the games, sometimes the sexes playing separately, sometimes one against the other, and inter-village contests were frequent. When playing the married women of rank, who usually wore long skirts, changed these for a shorter pattern reaching only to mid-thigh.

The evil spirit of the Tainan was known by the name of Maboya, and during an eclipse of the Moon it was thought that Maboya was devouring the satellite, and night-long dances were organised to the sound of gourd rattles.

There are some useful notes on dress and good instances of the evolution of ornament.

W. M. W.

ASTRONOMY.

An Introduction to the Study of Variable Stars. — By CAROLINE E. FURNESS, Ph.D. 327 pages.

(Boston and New York: Houghton Mifflin Co. Price 1.75 dollars [7/-].)

This volume is "one of a collection of notable volumes, by Vassar alumnae, published in commemoration of the fiftieth anniversary of America's eldest college for women." It fills a gap in our astronomical literature, and collects together a large amount of useful information that was scattered through a number of periodicals. It is equally available as a convenient book of reference to the expert, and as a mine of information to the learner. It contains a history of the subject, a reference to charts and catalogues, an account of the various systems of star magnitudes, and their reduction to the Pogson scale; star photometry by visual, photographic, and electrical methods. The step method of comparing a variable with reference stars is fully described, and it is shown how the star's period and light-curve can be deduced from the observations. The Cepheid, Algol, and long-period variables are separately described; and there are suggestions as to their physical explanation, together with an attempt to correlate the facts collected about length of period, colour, range of brightness, spectral type, and galactic distribution. In conclusion there are useful "hints to observers," culled from a variety of sources. The "step method" is so widely used by amateur observers that a summary of the full description given in the book may be of service. The standard charts of the field round variables contain stars of such magnitudes that we can select two—one a little brighter, the other a little fainter than the variable—at any point in the light-curve of the latter. Then each observer must form his own estimate of steps of light-difference. If after careful examination he can detect no difference in the brightness of the two stars he records their difference down as no steps; if he inclines to favour one, without being quite sure, it is recorded as one step; if he is just sure that one star is the brighter, the difference is recorded as two steps; and so on in uniform stages. The steps of different observers will differ. They must translate them into differences of stellar magnitude by tests on stars of known brightness. But they are recommended to make their records in steps, as their work is more likely to be uniform if they follow a scale adapted to the power of their own eyes to detect differences of light.

The method of using the selenium photometer, devised by Mr. Joel Stebbins, is fully described. The eye-end of the

XUM

telescope is surrounded by a great ice-bag, as the selenium works more uniformly at a low temperature. Then the observer opens a shutter, admitting the light of the star to the selenium cell, which is placed a little outside the focus, to give a larger image. The light disturbs the balance of a Wheatstone Bridge, and moves a spot of light on a scale, the readings being made by an assistant in another room. A series of comparisons of the suspected variable and of standard stars must be made. Many tests are required, owing to the liability of the cell to change its sensitiveness. Mr. Stebbins in this way detected the secondary minimum of Algol, and found that some spectroscopic binaries showed a small light-change, indicating a partial eclipse. The still more sensitive photo-electric cell, lately introduced, is also described. It has detected a small light-change in β Cephei, α Can. Ven., γ Boötis, Castor, o Persei. These results are of value, for they determine the orbit plane and the mass of the stars, which are otherwise unknown in the case of spectroscopic binaries. Enough has now been said to give an idea of the wide scope of the book, which should certainly find a place in every astronomer's library.

A. C. D. CROMMELIN.

GEOLOGY.

Methods in Practical Petrology.—By H. B. MILNER and G. M. PART. 68 pages. 6 figures in the text. 7-in. × 5-in.

(Cambridge: W. Heffer & Sons. Price 2/6 net.)

For many years it has been the practice of most English geologists to send all their rocks to Germany for slicing. This is now no longer possible, nor desirable, and the publication of a small handy book dealing with this subject is therefore very welcome. The authors describe very exactly and clearly the methods employed by themselves at Cambridge. These are very simple, and can be employed almost without any special apparatus beyond metal and glass plates and graduated carborundum powder. The treatment of rocks by pounding and separating in heavy solutions is described, and also methods of staining minerals in slices. A chapter on examination of rock slices is included, which is perhaps rather slight, but contains some very useful tables of refractive indices and birefringences. The book should prove of interest to those who wish to make their own rock slices, especially at the present time.

W. H. WILCOCKSON.

Textbook of Geology.—Part I: *Physical Geology.*—By L. V. PIRSSON. 444 pages. 311 figures in text. 9-in. × 6-in.

(London: Chapman & Hall. New York: John Wiley and Sons.)

This book is written to serve as a class-book for students taking the first course in geology. The author states in his preface that his object is to keep an even balance in the subject-matter, and more particularly to avoid writing a pure treatise on physical geography, as is so often done by writers of such books at the present time. This balance is very well maintained, and the whole science of geology is passed in review in a very interesting and readable manner. The book is divided into two parts: Dynamic and Structural Geology. The first part deals with what may be called "the active geological agents," such as running water, ice, and volcanoes; the second deals with the results of agencies which are not seen at work, and which can only be inferred from these results, such as intrusive rocks, mountain ranges, and ore deposits. The subjects are all treated in considerable detail, the separate parts being clearly divided off into paragraphs. The correlation of these separate parts, however, does not seem to have been made quite clear enough for the needs of elementary students. There is a somewhat more extensive chapter on ore-deposits than is usual in such books, and also a useful appendix of minerals, both of which are good, as they bring into view the economic side of the subject, which is often pushed so far into the background. The book is profusely illustrated with well-chosen photographs, and is furnished with a handy geological map of North America.

W. H. WILCOCKSON.

ORNITHOLOGY.

A Bibliography of British Ornithology.—By W. H. MULLENS, M.A., LL.M., and H. KIRKE SWANN. Part I. 112 pages. 9-in. × 6-in.

(Macmillan & Co. Price 6/- net.)

We welcome the appearance of Messrs. Mullens's and Kirke Swann's "Bibliography of British Ornithology," which deals with the principal writers on birds from the earliest times to the end of 1912. It is to be completed in about six bi-monthly parts, and the present instalment runs to one hundred and twelve pages.

A bibliographical account is given of each author or co-author of a separately published work, followed by a complete bibliography of his or her published works or contributions to works, and of papers contributed to journals (where such exceed one page in extent) which bear on British ornithology.

As a supplement to the whole work there will be added a geographical bibliography in which books and articles, as well as the ornithological matter in topographical volumes, will be arranged under county headings, and a chronological index to separate books published before 1850 will also be included.

Although the lives of the various naturalists concerned are necessarily brief, they will be found very pleasing reading, quite apart from their value from the reference point of view. The present part contains notices of Bell, Juliana Berners, and Bewick, and takes us as far in the alphabet as "Edward North Buxton."

We look forward to the appearance of the other parts of this important addition to published bibliographies.

W. M. W.

ZOÖLOGY.

A Veteran Naturalist: Being the life and work of W. B. Tegetmeier.—By E. W. RICHARDSON. 232 pages. 34 illustrations. 9-in. × 5¾-in.

(Witherby & Co. Price 10/- net.)

There can be few naturalists, sportsmen, or fanciers of poultry and pigeons to whom the name of Tegetmeier is unknown. They will be interested in this life of the veteran which has been written by his son-in-law.

From it they will learn how his tastes gradually got the upper hand over the profession of medicine, which he had first followed, and how, after teaching and writing, he was able to establish himself as an authority in several branches of natural history, and as an expert as regards poultry, bees, and game.

The general reader cannot fail to be attracted by the story of a man who lived from November, 1816, to the same month in 1912; who was a medical student before the time of anaesthetics; who was present at public hangings; who kept his faculties unimpaired; who made discoveries on bees; who was able to render assistance to Darwin; who upheld fair judging at shows; who was the father of pigeon fanciers and who was one of the earliest members and officers of the Savage Club.

In every way the "Life of a Veteran Naturalist" is well worth reading, and it is a matter for congratulation that there is this record of a thoroughly useful life.

W. M. W.